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Understanding Social Interactions with Augmented Reality

**APPROVED BY
SUPERVISING COMMITTEE:**

Jakki Bailey, Supervisor

Kenneth R. Fleischmann

Understanding Social Interactions with Augmented Reality

by

Gabriel Elijah Bailey

Report

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This project has presented a unique challenge for the researcher. There were quite a few times that the project itself seemed to be in a tough spot with no real ways of getting out. Thankfully, the researcher had the guidance of their supervisor, Dr. Jakki Bailey, who helped them stay on task and working towards the end goal. The researcher would also like to thank Islam Akef Ebeid, Ting Pan, Isabella Schloss, Sanjana Tripathi, and Siqi Yi for their kind words, suggestions, and motivations throughout the writing and researching process. Lastly, thanks are in order for Professor Kenneth R. Fleischmann for his assistance during the writing and revision process.

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Lessons Learned

The researcher would like to use this section simply to point out some of the lessons they learned during the creation and execution of the research project. This being the researcher's first time at creating and executing an entire study on their own, the researcher has learned that the process of coming up with an idea, researching that idea, and iterating on that idea when it inevitably does not go according to plan are all difficult and necessary parts of the research process. As a junior researcher, learning how to conduct a study professionally and efficiently is something that requires practice and patience. This project has given the researcher the beginning tools that will be further refined in future studies.

Abstract

Understanding Social Interactions with Augmented Reality

Gabriel Elijah Bailey, M.S. Info. Stds.

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Supervisor: Jakki Bailey

This report examines the ways that users share information using augmented reality (AR). In order to accomplish that goal, the researcher (with the help of their supervisor), conducted interviews of two participants. In those interviews, the participants were asked questions about their sharing behavior on and offline along with their current usage of social media. After the interviews were conducted, the participants were given an AR app called Krikey to use for a period of time. At the end of that time, the participants reconvened with the researcher and answer a few more questions regarding their experience with the AR app and their sharing behavior on the app. The report, through thematic analysis and descriptive statistics, found that the participants were more willing to share information through AR when interacting with groups and individuals with whom they were familiar. On top of that, the users expressed concerns regarding privacy and social interaction within the app. This study provides a preliminary step toward better understanding the sharing habits of users in AR.

Table of Contents

List of Figures	viii
INTRODUCTION	1
Social Information Sharing.....	2
Technology as Information Sharing	6
Augmented Reality and Social Information Sharing.....	12
METHOD	17
Overview of Study	17
Research Questions.....	17
Hypotheses.....	18
Measures	18
Demographic Questionnaire	19
Follow-Up Questionnaire	19
Procedures.....	19
Data Analysis Plan.....	20
RESULTS	22
Behavioral Responses	22
Users' Perception of Social AR.....	26
Community Influence on Personal Identity in AR	28
Privacy and Social AR.....	29
DISCUSSION	31
FUTURE WORK.....	33
Group Behavior.....	33

Ethics of AR	34
Limitations of Study	35
CONCLUSION	38
Appendices.....	39
Appendix A.....	39
Appendix B	42
Appendix C	44
References.....	45

List of Figures

Figure 1:	Sharing/Environment	4
Figure 2:	Sharing/Technology	8
Figure 3:	Social Media Use	10
Figure 4:	Mixed Realtiy Spectrum	14
Figure 5:	Wingspan Landing Page	22
Figure 6:	Gorilla Game.....	24
Figure 7:	Wingspan In-Game	25

Introduction

The field of Human-Computer Interaction (HCI) began when human beings became more enamored with the possibilities of computing systems and their potential benefits to society at large. The relatively niche section of computer programmers and engineers utilized the machines to complete a variety of tasks that ranged from code breaking to simple, yet time consuming, math problems. As the years continued, programmers and hobbyists began to use multiple computers in conjunction with one another in order to form networks. Now, in the present age, these networks have become so interconnected with the needs of humanity's day-to-day efforts that it is hard to imagine the two ever being separate. Human beings use computers in order to play games, connect with friends and colleagues, manage their finances, shop for food and clothing, and even buy housing.

Augmented Reality (AR) is becoming a more prevalent technology. AR technology presents a digital overlay on to a physical space through another device (i.e. smartphone, smart glasses, etc.). In doing so, AR allows the user to see digital information and projections while also interacting with individuals and objects in the physical world. AR presents society with an even deeper level of immersion with the digital world while still maintaining the boundaries and spatial understanding of the physical realm. Companies like Google (with Google Glass) and Microsoft (HoloLens) are working on ways to incorporate AR into our everyday lives. With widely available mobile phone applications like Krikey and A-Frame, AR is quickly becoming a go-to

technology for hobbyists and general consumers. However, there is little data to be found relating to how humans utilize this technology socially.

The goal of this study will be to better understand the ways that people share information through, and interact with, an AR application. Specifically, this paper focuses on the intersection between current social sharing practices and augmented reality. By examining users' social interactions with AR, this study hopes to shed light on the ways that humans interact with each other and the ways that AR can enhance those interactions.

Some specific areas of note that could see further expansion upon are the root causes of social sharing through AR and the effects of long-term access and use of an AR system on human socialization. An examination of the long-term effects of exposure to an AR system would help society better understand the role that AR plays in the ever-increasing digital age. With further exposure to AR systems and further familiarity with its limitations and use cases, users may begin to rely on AR for more social interactions.

Social Information Sharing

As stated above, the purpose of this study is to examine the sharing habits of humans using augmented reality. In order to properly examine sharing, some key definitions need to be established. The main concepts that aid in sharing are social behavior and information creation. Social behavior relies on sharing because, in order to share, one must engage in a certain level of social interaction. There are a variety of ways that human beings share and interact with each other. For example, people can conduct business, gather for parties, engage in political discourse, report news, show affection,

share gifts, play pranks on each other, and many other activities. Each of these activities are carefully constructed social dances that the vast majority of humans do not notice. This is because, while pivotal to the overall functioning of society, humans do not tend to focus on the reasons and the ways that they interact. The interactions seem to come as second nature to most people. This is due, in part, to the way that humans are raised.

Humans exhibit positive social behavior towards others as early as two years old (Brownell, 2016, p. 223). For instance, children, by being able to stand upright, are able to communicate face-to-face with each other and maintain a shared focus on objects and individuals (Brownell, 2016, p. 223). This continued focus, as Brownell points out, allows for the further development of social behaviors and agreed upon societal roles (those being the bonds between a caregiver and the child, the child and another child, etc.). These agreed upon roles create structures within which each individual can belong and operate. Once the structures are established, a society can begin to take shape. With that in mind, a society does not simply operate based on the physical actions of human beings alone. There is another layer to the interactions that focuses entirely on the information that these individuals create and communicate.

Information, for the sake of this study, is any piece of new or old knowledge learned or rediscovered from a source outside of one's self. For example, if someone is walking down the street and sees another person jogging by, the information shared between these individuals is the fact that one person is walking and the other is jogging. The reason this definition is so broad is due to the fact that human beings currently receive and share information in metacontextual ways. Humans can communicate with

each other through sight, touch, scent, taste, and sound (otherwise known as the Five Senses). By maintaining a wide breadth, the definition of information for this study can begin to incorporate a variety of sensory inputs which allows the sharing of information to occur in a variety of ways and through various mediums.

These two concepts, information creation and social sharing, influence each other in order to create a new concept of sharing. Therefore, social information sharing is dependent on certain social factors that are inherent to one's environment. The environment can be described as both the physically inhabited space of individuals (i.e. the room that someone is in) and the implicit ambiance that is created by the people in that space (i.e. the group and their level of interaction). Sharing can help create new environments that, in turn, affect the information that is shared. The information shared can then affect the environment. This synergistic effect (as shown in Figure 1) can be seen throughout society. For example, in a library, the information is shared through books that are

literally read by each individual.

At the same time, the library itself has various rules in

order to simply operate, move,

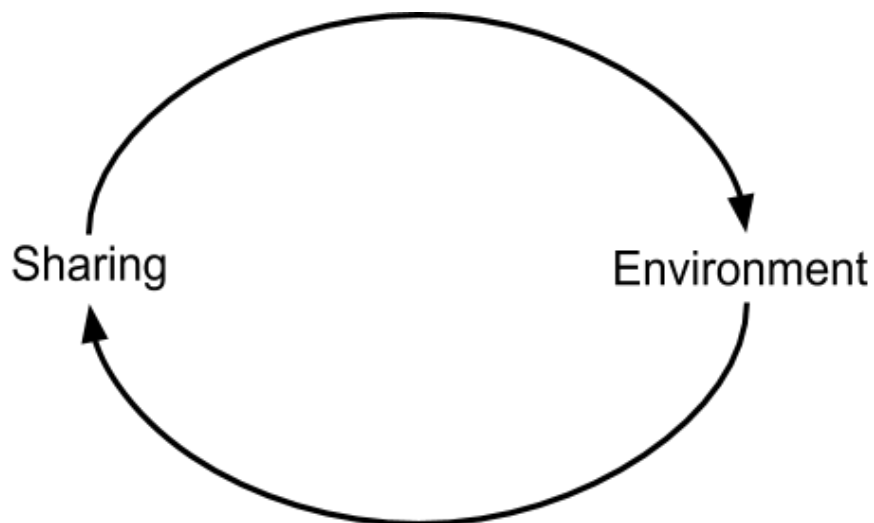


Fig. 1 - Diagram depicting the reciprocal nature of sharing and environment

and act within it (i.e. being quiet, not disturbing others, etc.). These rules are stated and implied both by the library and the library's patrons. The example of a library is also useful for understanding the ways that group size and environment affects sharing practices. This study will not dive into all of the factors that contribute to group formation and organization (like trust, social hierarchies, etc.), primarily due to time constraints, but the basis of a vast majority of active and passive information sharing occurs within a variety of groups thanks to a shared set of social and cultural norms that stem from assimilation to the group. "As a consequence, evaluations of individual group members tend to be biased in the direction of the knowledge we have about the group as a whole an effect generally referred to as assimilation" (Spieß and Bekkering, 2019, p. 4).

More importantly, these shared cultural and social norms establish specific patterns of behavior. Although environment plays a big role in sharing, the act of sharing is what truly matters. In order to share, a group or bond must be formed. A short working definition of a group is a gathering for intended interaction between any two or more individuals. In the case of grouping, Palla, Barabási, & Vicsek point out that they "... find that large groups persist for longer if they are capable of dynamically altering their membership, suggesting that an ability to change the groups composition results in better adaptability" (2007, p. 664). The altering of groups and speed that those groups can alter changes the group's overall ability to survive. It is within these groups that information is passed. Another factor relating to groups and their formation is their level of similarity. These similarities can also be found thanks to individual group members and their ability to assimilate to the group. "Importantly, assimilation also implies that the perceived

variability within the category or social group decreases, thereby making individual group members appear more similar” (Spieß and Bekkering, 2019, p. 4).

As it stands, groups consist of a variety of roles and exist throughout all aspects of society. Each member of a group contains a certain amount of knowledge or information that can then be shared with the rest of the group. The continued sharing of information leads to further assimilation within the group. “Yet not all cultures are equally receptive to it, and the process of assimilation may require great effort and patience. Furthermore, different cultures will tend to generate or select different technologies, so that the actual technological system that is chosen will be culture-dependent” (Brooks, 1980, p. 66). Brooks points out a few very critical points regarding groups, the cultures that exist within those groups and the use of technology as a specific tool for further assimilation among the members of those groups.

In the next section, the researcher will further discuss the ways that groups and individuals interact and share information online using those technology and medium specific tools like social media.

Technology as Social Information Sharing

As the previous section touched on, human beings are very social. One of the ways this social behavior manifests itself is by the formation of groups. The social act of communication and sharing information among these groups can be seen as technology because of the reliance on codified and agreed upon definitions of roles within society. For example, within our society there is the established and agreed upon norm of the relationship between the government and its citizens. The members of the government

are tasked with passing and upholding laws that help the citizens of the nation to feel more protected, at least on paper. If the government does not uphold their end of the relationships, the citizens, as stipulated by the law of the land, are allowed to seek alternative leaders who better represent them come election time. The roles themselves, in this case the roles of government and populace, were created to increase survival chances. These roles require certain levels of communication in order to succeed. To further the example, if the government does a poor job of sharing specific pieces of information regarding the safety and well-being of the people, then it is up to the people to find new leaders to have their needs met. This creates a group dynamic with clearly stated rules that allow for each person to know where they stand within the group and how they can interact with and alter the general makeup of the group.

Through the formation of groups, humans have been able to create great products and services that continue to assist humanity to this day (for example, the furthering of space travel, faster and more accurate computers, renewable energy sources, etc.). A good example of the progress that can be made by humans continual bonding, organization, sharing, and communication can be seen during the Neolithic Revolution. Thanks to the Neolithic Revolution and the advent of farming and community building, humans were able to cohabitate and socialize in large groups (Bocquet-Appel, 2011, p. 560). The Neolithic Revolution is an especially useful example because it shows the power of humans creating tools and furthering their technological development along with using that technology to bond and share more with each other. The ways that people interacted with each other changed from splintered, dramatically separate groups into

larger and more unified clusters (Bocquet-Appel, 2011, p. 560). These clusters could then begin to focus more on technological development (since issues of survival began to diminish). “It is also important to observe that the process of creating technology for the first time is quite different from the process of specifying it so that it can be reproduced by others. The creation process is culture-dependent, but its reproducibility makes it technology rather than art” (Brooks, 1980, p. 66). The more technology that was developed, the better the group could share and communicate, which led to even more effective technological developments at which point the cycle repeats itself and more effective communication is created (see Figure 2).

Technology has played a large part in the overall evolutionary cycle of the human being and an even bigger part in the way that humans communicate with each other and form groups. “The Edison electric light, the Xerox copier, the computer, the Polaroid camera, the automobile, the television system - all involved concepts of complete

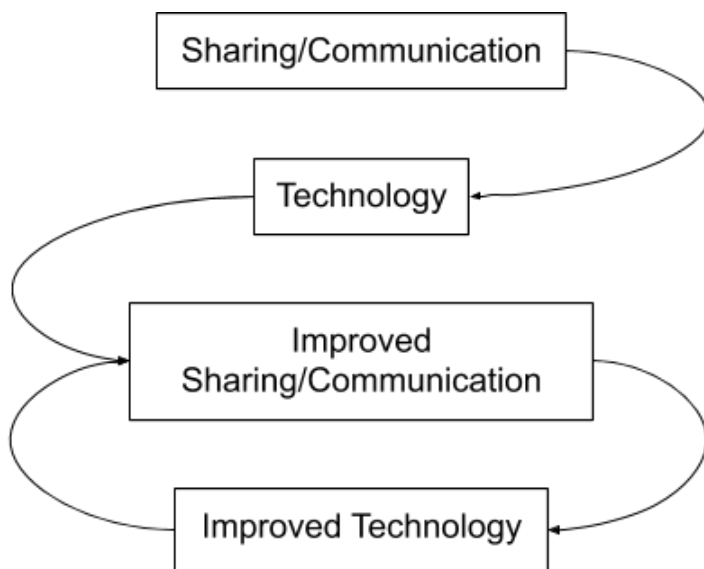


Fig. 2 - Relationship between sharing and technology growth

technological systems that included supporting organizations and markets” (Brooks, 1980, p. 65). The examples that Brooks home in on showcase an interesting phenomenon. Almost every one of them can

contribute to the ways that humans share information in some shape or form. The light bulb allowed humans to stay up longer and interact with each other at all hours of the night. The copier and camera gave humans the ability to reproduce exact replicas of moments or pieces of information to share with each other or to better keep track of records. The car gave humans the ability to travel great distances in order to meet and associate with each other. Each of these inventions and technologies had the cumulative effect of making the world a smaller and more manageable place. By shorting the physical and temporal links that bind us, humans were able to share and create groups that lasted and spread across time and space. However, of the list that Brooks mentioned, none of these technologies have altered how humans socialize more fundamentally than the computer and, by extension, the internet.

One of the more interesting aspects of the newly connected globe are the social interactions between humans using the digital medium as a conduit. Currently, the Internet has become the primary source of change that influences current human sharing and interaction. The global information structure known as the internet came about in the late 60's as a byproduct of a DARPA defense initiative (Clark, 1988, p. 106). In its present form, the internet is arguably the single most important tool for information sharing in society. This is due in part thanks to the prevalence of smartphones that allow more convenient access to the internet. As Anderson (2019) points out, "Fully 81% of adults now say they own a smartphone, up slightly from 77% in 2018. Smartphone ownership is relatively common among Americans of different economic, educational and racial and ethnic backgrounds." With the advent and ubiquity of social media, the

Internet has become even more than the sum of its parts. Now it is possible to meet, interact, relate, and share individual moods, news updates, life events, and more thanks to the social aspects of this communication medium. Technologies that incorporate information sharing via a network (i.e., the Internet), have the potential to transform social interactions.

With the development of social media outlets like Facebook and Twitter, and the increased presence of smartphones, human beings have access to each other in surprisingly new, and shockingly intimate, ways. As seen in Figure 3, individuals between the ages of 16 to 24 spend approximately three hours on social media every day. “Moreover, Internet users who have been connected 3 or more years are the most likely to have many people to turn to, visited someone yesterday, or called someone just to talk because they became users at a time when Internet connectivity was even more

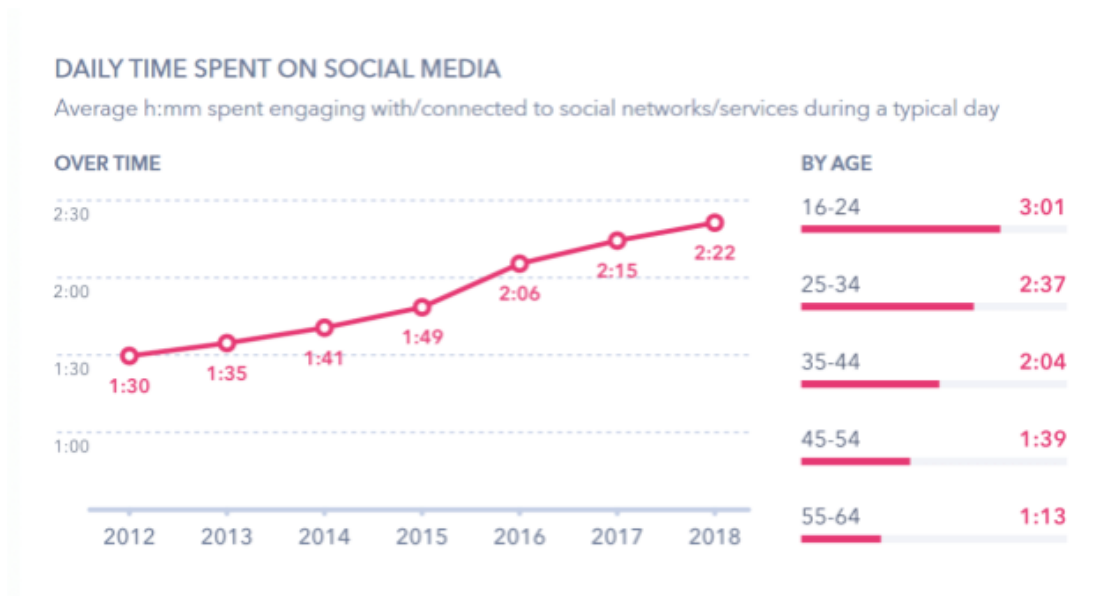


Fig. 3 - Graph showing average use of Social Media time provided by Global Web Index (Salim, 2019)

education-, income-, and age-biased” (Nie, 2001, p. 428). As Nie points out, various physical world indicators change the way that technology is used. By that same thought, it could be argued that the content that is shared using the medium varies because of the social factors that come with differences in education, income, and age. While Nie’s study is now a bit dated, the core argument still appears to hold today. Take LinkedIn, for example. Since LinkedIn’s whole platform is geared towards connecting professionals for job opportunities, the changes in social status and the information that is shared between those social groups can be even more closely compared since salaries and income are so closely related to jobs and job categories. A 2014 Pew Research Center survey shows that 28% of internet users use LinkedIn (Duggan, Ellison, Lampe, Lenhart, & Madden, 2015). Research has shown that LinkedIn use is higher among individuals with higher incomes as well as individuals with higher levels of educational attainment (Duggan et al., 2015).

With that said, it is not hard to imagine that these different subgroups of LinkedIn users utilize the platform in separate ways. For example, students share information related to finding internships, jobs, school events, and other school related tasks. User Experience designers share design ideas, journey maps, best design practices, job postings, work-life balance information, and other things related to that specific field. With the advent of better-connected individuals through the rise of social media and internet use, came the rise of online communities that are geared toward specific types of interests and behaviors (i.e. LinkedIn is for professional use, Facebook is for personal use, Twitter is for personal micro-blogging, etc.). Even in the cases of these very specific online communities, a lot of overlap can be seen that begins to change the ways that the

users share information the types of information shared by users. Twitter and Instagram are thought to be primarily used as personal sites where users can share life updates with close friends and family. However, there is a large quantity of users who also use Twitter and Instagram to promote their businesses and brands in order to gain more profits. Therefore, the use of the site, while personal on some levels, is also extremely focused on catering to businesses and allows for those businesses to enter into the social lexicon as individuals with their own personal thoughts and ideas. These examples are used to illustrate the point that social behavior online is influenced by physical world structures (i.e. businesses, friends and family, school, work, play, etc.) that can then alter the ways that regular users interact with each other.

“Technology, therefore, does not consist of artifacts but of the public knowledge that underlies the artifacts and the way they can be used in society” (Brooks, 1980, p.66). As it stands, technological advancement can be seen as one of the main drivers of humanity's success on the macro level. That same success can also translate into the unique social groups that are created and maintained through technology. As technology continues to grow, it also continues to invade human life in bigger and more creative ways. As such, it is not hard to imagine a time when humans and the networks they created will be completely merged and intertwined. The next section examines one of the technologies that currently attempts to blend the boundaries between the digital and the real, augmented reality (AR).

Augmented Reality and Social Information Sharing

Technology is constantly growing and changing to meet the needs of its users. As explained in the section above, the needs of those users vary depending on the groups and the individuals that make up those groups. For the sake of this report, the researcher has focused on the social aspects of these groups and the ways that individuals interact with each other through these developing technologies. Within that context, AR presents some interesting new challenges and ways for users to share and interact with each other. In order to discuss AR, the researcher will begin by describing exactly what the term means and some of the history behind the technology's creation.

To start with, AR need to be defined. In short, "AR systems integrate virtual information into a person's physical environment so that he or she will perceive that information as existing in their surroundings. Mobile augmented reality systems (MARS) provide this service without constraining the individual's whereabouts to a specially equipped area" (Höllerer & Feiner, 2004, p. 1). As Höllerer & Feiner point out, AR allows the user to move and interact with the digital while still being aware of the physical world. This blending is done through various systems directly interacting with each other. By combining fields like artificial intelligence, computer vision, digital asset creation, and many others, AR creates a unique visual and physical experience.

AR exists within the realm of Mixed Reality (MR) technologies that were initially developed in the late 60's/early 70's by various schools and companies (see Figure 4 for a graph that details the Mixed Reality continuum). One of the earliest and well known of the head-mounted immersive displays was informally called the Sword of Damocles and was developed by Ivan Sutherland and his research team consisting of Robert Sproull,

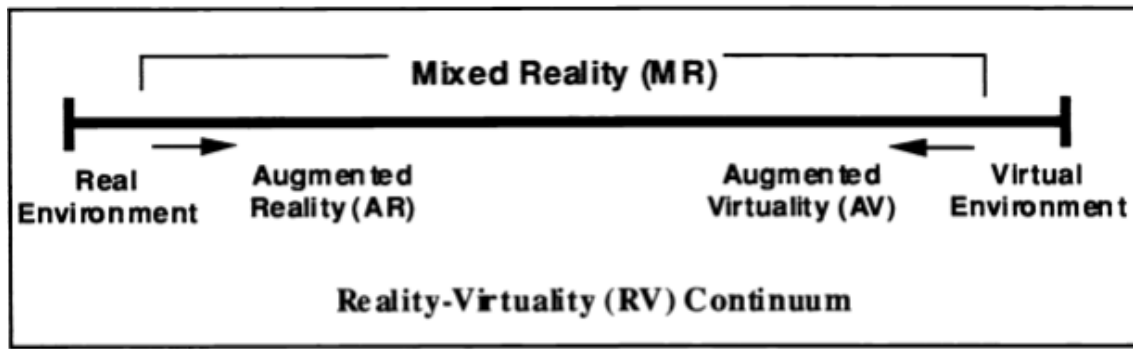


Fig. 4 - Mixed Reality Spectrum (Milgram, Takemura, Utsumi, & Kishino, 1995)

Ted Lee, and Dan Cohen at the University of Utah (Sutherland, 1968, p.757). In his paper *A Head-Mounted Three-Dimensional Display*, Sutherland describes the idea of wanting to create a display that changes what the user sees as they move around an area in real time. The primary reason why Sutherland is so important to the AR/VR conversation is because he helped pioneer the ability to change the information that is visually displayed to users as they move (moving being the operative word). Prior to Sutherland, the displays that were immersive in any sense of the word were stationary and required the user to look through the device from a specific angle. The restriction, therefore, limited the level of immersion possible for the person using the device. By combining the digital and the physical in a somewhat seamless experience, Sutherland helped open the door to furthering AR technology towards its current state.

Current AR has jumped lightyears past the days of Sutherland and his colleagues. Various companies and corporations have begun to dive further into the AR/VR space and are making strides toward furthering its development. An example of this is Microsoft and their HoloLens technology. The HoloLens is essentially a pair of goggles that overlay digital information onto the wearer's field of vision while allowing them to

see and interact with the physical world around them. These AR goggles are one of many commercially available technologies that specialize in the field of mobile AR. However, with the rise in personal computers through the newfound ubiquity of smartphones, AR is capable of permeating society in new ways. AR games like Pokémon GO and Krikey utilize the computer power, cameras, and internet connected capabilities of smartphones to present users with AR in new, and more social, settings.

Both Pokémon GO and Krikey present interesting new cases for social interaction because of their unique potential to engage individuals through the medium of games. Pokémon GO tasks players with traveling to different physical spaces around their cities and neighborhoods in order to find and collect different Pokémon (fictional animals and creatures from a popular Japanese cartoon and game series). The AR aspect of the app relates to the navigation system that Pokémon GO uses and the use of the smartphone camera and device to overlay digital creatures on real world objects (for example, seeing a Pikachu sitting on a park bench or a Squirtle walking across the street). By having the virtual creatures interact with real world environments, the player is given the illusion that the creature physically exists but can only be seen through the smartphone. Regarding their work on social interactions with embodied agents in AR, Miller, Jun, Herrera, Villa, Welch, and Bailenson stated that their work, "... suggests that the more virtual content reacts to the physical environment, the more virtual humans seem real" (2019, p. 3).

Miller and colleagues continue on to explain that AR is uniquely positioned to increase user engagement with the embodied agent because the users prefer agents that

interact with things in their immediate vicinity and that act in a manner that is socially expected of them, as opposed to some disembodied voice coming from a speaker or headphone (Miller et al., 2019, p. 3). The level of sociability for users and embodied agents is important for the future of AR. This study would like to extend that level of social interaction to humans and their interactions with each other through augmented reality. One game that begins to examine this area is Krikey, which is why Krikey was chosen by the researcher and their supervisor for this research project. The app and some of the interactions that occur within it will be discussed in more detail in the Discussion section of this paper but the main idea behind the app is to allow users to interact with each other through video recording, sending, and community sharing. This study was designed to examine these types of interactions in order to see how AR affects the sharing medium and what that means for the future of sharing. With that in mind, the next section describes the methods used to conduct this study.

Method

Overview of Study

The purpose of this study was to examine the factors that contribute to a user's ability to share within an AR application. This study is separated into two parts. First, the participants will be selected and given a questionnaire that covers different aspects of their social behavior (both online and in real life) along with the participants previous interactions with AR. Second, each participant will be given the app and asked to use it for up to ten minutes, followed by an interview to get a baseline of their interactions within the app.

In the future, a third longitudinal portion would be attached to this study. In that section, the participants would be given a week to use the app in their daily lives. After the week is up, each user would then be given a questionnaire to determine the quality of their interactions and to see if they enjoyed using the app as a social tool. This third section was cut from the primary experiment so that the researcher could have time to focus on the immediate reactions of the participants and gather solid data points regarding that information. The follow-up questionnaire that would have been used is also attached to this paper for any future researchers to utilize in their experiments.

Research Questions

This research began as part of the researcher's interest in HCI and the future of AR technologies. The realm of sharing within each of these spaces has not been discussed much and led the researcher to inquire more heavily into that subject. As such,

the following research questions were the guiding lights for this study in order to focus the scope of the project:

1. How do users share information and interact with each other through AR?
2. What information do users share in AR?
3. How does the sharing of information through AR affect the ways that humans naturally socialize and share with each other?

Hypotheses

As this research was more exploratory, there was no specific hypothesis that the researcher created or theorized. Examining the effects of sharing and, on a broader level, socialization were the primary goals of the study. The findings discussed below will further describe the nature of the experiment and the overall results of the study.

Measures

The goal of this study was to initially see the social use of the Krikey app by multiple users over the course of a week and record those interactions. However, this goal was adjusted, and the focus of this study became more concerned about the immediate reactions of a select few users. Therefore, the main measures taken in this study were related only to those two participants. Since the data set is so small, the researcher thought it best to use descriptive stats and focus in on the behaviors of the participants along with their background with augmented reality and social media to get a more holistic picture of the interactions that the users had. Those measures are included and further described below.

Demographic questionnaire. There were two primary participants in this study. Both participants were White. Participant 1 was a male and the other, Participant 2, was a female. The Participant 1 was in their mid-twenties and Participant 2 was in their early thirties. Both participants had bachelor's degrees and were working towards receiving a master's degree at the time this study was conducted. Appendix A contains the Preliminary and Interview questions that were asked to both participants.

Follow-Up Questionnaire

The Follow-Up Questionnaire would have been given to users at the end of their week spent interacting with the app. The primary focus of the questionnaire was to see how the users interacted with the in-app community, other social media platforms, and their own friends/family. The questionnaire itself can be found in Appendix C of this paper. For future studies, the researcher suggests that the questionnaire be updated to better examine any of the Krikey app's potential feature changes.

Procedures

In this section, the research will describe the overall procedure that occurred when conducting this study. This study began with the idea of focusing on sharing and growing/emerging technologies. As such, the researcher focused the creation of this project around that concept. When conducting the experiment, the researcher first took the individual participants to a quiet study room with enough space to allow them to move fairly freely without bumping into anything or anyone. Next, the researcher administered the initial survey and recorded the participant's responses while simultaneously taking notes on what they said. Following that, the researcher told the

participants to use their personal device and download the Krikey app from their phone's application store (as the app is commercially available for free to anyone with a smartphone device and access to their app store on either Android or iOS devices).

Upon completion of the download, the researcher explained to the participant that they would have ten minutes to interact with the app and that they should speak aloud about their use of the app and the thoughts that ran through their minds as they used the app. The researcher then set a timer and took notes as the participant wandered about the room, poked around the app, and interacted with the different games and settings within the app. At the end of the time, the researcher asked the participant to sit back down in a chair and then the researcher began to ask them a few follow up questions about their app and sharing experience. Once complete, the researcher thanked them for their time and escorted them out of the room.

Data Analysis Plan

Thematic analysis was used to examine the relationship between sharing and augmented reality. Thematic analysis consists of finding themes in qualitative data (Braun & Clarke, 2006, p.80). This analysis was done with no formal hypothesis. Analysis was conducted to the semantic level of data analysis. This allowed for a more specific examination of the data and helped find emergent, surface level trends that related to sharing within the application.

The theoretical theme being teased out of the data is focused on the interaction between sharing using AR technology. The data was collected and examined for instances that involved the mention of information sharing. The sharing could be as

simple as showing another person the AR video they made on the device itself or by sending a message to another user either through the app or through another method. For this preliminary study, a broad definition of sharing was used to increase the likelihood of finding data points that matched the theoretical framework.

Aside from the use of thematic analysis, the researcher also thick description (Geertz, 1973, p. 317) in order to examine and describe the specific details that the participants stated over the course of their interviews. This allowed the researcher to piece together a narrative that could be used to better understand the interactions that occurred for the participants along with helping discover more robust and generalizable themes.

Lastly, this study is based on a first notes analysis. In the future, full transcriptions could be taken of the recordings that the researcher took. At this time, the researcher will focus their attention on the handwritten notes along with the audio recordings without a transcription. This allows the researcher to focus on finding trends within the results.

Results

Behavioral responses. As stated above, the study began with the participants being interviewed about their demographics and personal background in relation to sharing and AR. After that, the researcher gave the participants a chance to use the AR app for ten minutes. Within that ten-minute time frame, the participants were asked to explore the app itself and utilize the app as they saw fit. Below are some of the behaviors that occurred when observing the participants as they moved about the room, speaking aloud and utilizing the app.

Participant 1 began using the app after a quick tutorial was given by the researcher to them. After navigating the app and learning

how to find games, Participant 1 began to play a game called Wingspan within the app (as shown in Figure 5). The game tasks players with finding a variety of birds within their environment. To do that, players must lure birds into their immediate vicinity by offering various treats in the form of berries and bugs. The player can also navigate a map interface that shows the user's surrounding location (i.e. street names, buildings, parks, etc.) which is intended to give players the ability to collect other birds that can only be

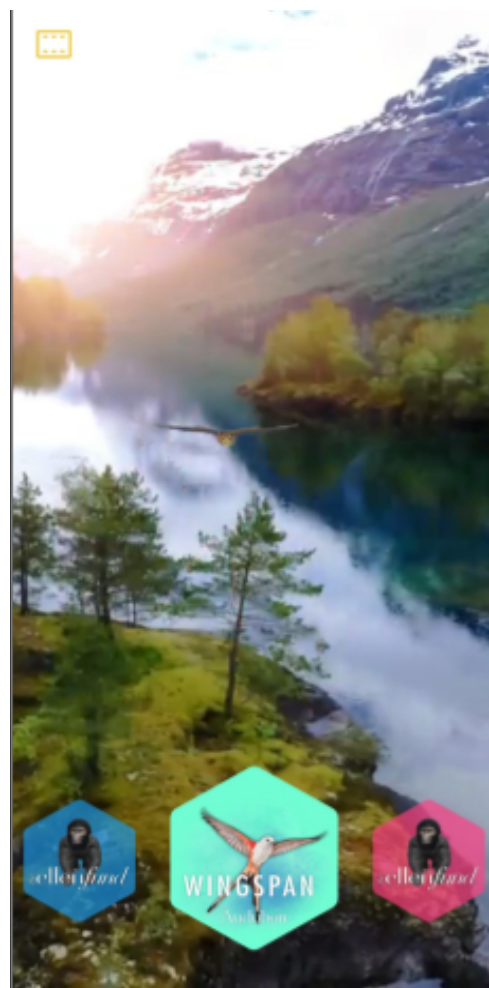


Fig. 5 - *Wingspan*, one of the games in Krikey

found in specific areas. After finding and collecting the birds, players can then share their collection with other users and share short videos of their interactions with the creatures that they found. Participant 1 was able to find one bird in the room but was also hampered in their ability to find more as they were confined to the testing area that the researcher established.

However, within the space, Participant 1 was able to manipulate their physical position in relation to the bird that they saw by crouching down and attempting to get as close to the bird as possible. Participant 1 stated that they moved in this manner primarily because the space that the bird occupied seemed too small on the phone and they needed to get closer in order to see the bird better and swipe the food/treat toward it more accurately. The participant also said, “imagine doing this in public” in relation to their awkward squatting and posturing in order to use the app. Once Participant 1 managed to capture the bird, a short video recording was taken of the participant by the app. However, the participant made it a point to skip the video portion that would record their face and the participant made sure to not share their video with the Krikey community or any other social media platforms. When prompted on why the participant reacted that way, Participant 1 stated that the video was not funny enough to share with others and that they did not want their face shown on camera to other people. The researcher did not question the motivations behind the refusal of Participant 1 to show their face on camera. Upon capturing the bird and skipping the video, Participant 1 sat back down in their chair and began to interact with the app more closely. As the participant sat and described



Fig. 6 - Gorillas game played by researcher

their interaction with the phone, the researcher made it a point to home in on the specific sharing interactions that the user was attempting to use.

The primary impressions that Participant 1 had of the app seemed to be that they did not like some of the sharing options presented to them. For example, one of the ways that users can share on Krikey are to email their videos. The participant believed that the idea of emailing a video to their friends was very outdated. The participant was also very concerned about their friend list and the ways that the liking system worked. Participant 1 was also curious about the sharing of other people's videos. There are a few more key insights that can be gleaned from

Participant 1 but those will be discussed further in conjunction with Participant 2 in the Users' Perceptions of Social AR section.

Participant 2 used the app in a similar manner to Participant 1 and seemed to enjoy their overall experience with the app. Over the course of the interaction, Participant 2 spent most of their time working with the Gorilla game, an example of which can be seen in Figure 6. In the Gorilla game, users are tasked with traversing through an AR rainforest. Within that rainforest, they can find a variety of creatures and foliage. The

main task of the app is for the user to collect different foodstuffs for the gorilla within a given amount of time. So, users walk around the space, pulling on bamboo and knocking over ant colonies to collect them as treats to feed to their gorilla agent. Within this task, Participant 2 moved around the area, stooped over to get closer to the gorilla agent, and made repeated attempts at adjusting the space that they interacted with the app in (by doing things like stepping over and sitting in chairs to get better viewing angles within the app).

The participant seemed to be more agitated at the fact that the area that needed to be explored kept altering in size, which forced them to change positions in order to collect more treats. Curiously, Participant 2 also made it a point to place the AR environment over the researcher as they observed. The researcher believes that the participant was both attempting to be humorous while simultaneously testing the mapping capabilities of the AR app itself. Once their time was up, Participant 2 also sat down and began going through the videos of some of the

community members on the app as well. Uniquely, Participant 2 also made an attempt to share their video with the community as well but failed because the app requested a sign in option that the user was unaware of initially. After the researcher assisted the



Fig. 7 - Wingspan AR game captured from the researcher's personal use

participant, they were able to successfully share their creation with the Krikey community. In the next section, each participant's use of the app will be compared to their previous perception of social media and AR app use.

Users' perceptions of social AR. As stated above, each participant was interviewed about their social media use and then given a chance to interact with the app for ten minutes. At the end of that ten-minute session, the user was then asked a few questions regarding their interactions with the app and the sharing that took place within the app. This section will examine some of the responses that the participants gave in order to create a picture of what interaction in AR can look like and achieve. There will also be a discussion of some of the pretesting that the researcher did within this section. For reference, the specific questions asked can be found in Appendix A of this report.

The researcher conducted pretesting with two individuals before conducting the official study. During this stage, the researcher simply observed as the users utilized the Krikey app and followed up their usage with questions related to the app and sharing within the app. Of the two informal interviews, one of the users raised a curious point about the need for privacy within their sharing community. When prompted for further information by the researcher, the user specified that they were concerned with their personal image and face being shown to a group of people that they did not know on an app that they only recently learned about. On top of that, the user seemed confused and irritated at the app for recording their face without seemingly giving them the option to skip or ignore that particular feature (note: Krikey currently allows for this feature and gives the user a 5 second window to skip the video before sharing their creation).

The second informal user also brought up an interesting point regarding sharing within physical space while using AR. The point they brought up was that they would prefer to interact with the app along with their friends in real, physical space in order to see their reactions and in order to observe them as they awkwardly moved about their environment. Both of these pretest participants pointed out interesting issues and ideas within the AR sharing framework that could be used to encourage further interaction, which will be discussed in the Discussion section. With that said, the two primary participants within this study also shared some interesting insights regarding sharing and AR.

Participant 1 described their interactions and perceptions of the app itself as, “pretty cool” and “neat”. This stemmed from their overall interest the technology associated with AR, in general. The participant seemed to believe that the app was geared towards getting users more active, as opposed to getting users to share their interactions with friends and a community of like-minded individuals. Participant 1 also pointed out that, since the app was more geared towards movement around a space, there was really no option to utilize the app from a stationary position. In relation to using the app in social settings, Participant 1 stated that they would like to use this app with their friends in a more competitive manner along with being able to send gifts to their friends. When prompted about sharing their created videos with friends, Participant 1 stated that the likely hood of them sharing their creations in the Krikey app would increase if their real friends were already using the app and if the actual graphical fidelity of the app’s animals were improved.

Participant 2 stated that they also enjoyed the app and found it to be “lush”. The participant found that they enjoyed the animals and also found the technology of AR itself to be “cool”. The participant stated that they would also find the app more interesting if they could add text to their created videos within the environment and if they could completely customize and redesign their physical space within the AR app. As mentioned earlier, the participant was able to share their video creation with the Krikey app community. When asked why they decided to do so, Participant 2 stated they were simply curious to see what would happen and that they wanted to share their point of view. At this point, the participant also stated that they would be interested in the ability to send direct video messages to their friends that consisted of their physical environment being modified by the AR app. Participant 2 also stated that they would be more interested in sharing their AR video through other platforms like Instagram and Facebook. The participant felt that the AR app could be used as a bonding tool that allowed the user to be closer to someone even when they were not directly accessible (i.e. friends in other countries or cities) in order to “share the experience with them”. Finally, Participant 2 stated that they felt the app did not express its main goals thoroughly enough for them to understand the point, or the specific use cases, of the app.

Community Influence on Personal Identity in AR

In the process of deciphering the data, a few key components arose. First, participants seemed to focus their attention on the way that their shared videos would be perceived by the communities they shared them with. For example, Participant 2 stated, “My username would’ve been different if I had known that other people would see it.”

Likewise, Participant 1 refused to share their video or face with the Krikey community or their own personal Social Media accounts because the video's content "wasn't funny or interesting enough." Both participants seemed more interested in the way their shared information would be received by others, regardless of if they personally knew that person outside of the AR app or not.

This point begins to touch on issues associated with social and personal perception and how those two fields interact with each other. Even when compared to their personal social media use, both participants only interacted or shared information with friends and family when they believed that it was of great enough concern or interest to their respective groups (which consisted of friends, family, and inner circle members). Both users did not want to share any information that would be seen as uninteresting or "out of character" to their pre-established patterns of behavior on their social media profiles. Therefore, the interactions that occurred on the Krikey app, in order to be useful and shareable, had to match up with the users already established idea of self. This leads to an interesting question and position for AR. What purpose does AR serve and how does that purpose directly affect the ways that people see themselves? If the goal of the application is to get individuals to share and interact more, than the technology itself must align with what users already believe and are interested in regarding themselves.

Privacy and Social AR

Issues of privacy and belonging seem to go hand-and-hand when describing the interaction of sharing. Both participants touched on the concept that sharing, of any kind, varies and deeply depends on context. For example, Participant 1 stated that the

information they would share to a classroom full of people would be less specific and less accurate than the information they would share with a friend in a one-on-one setting.

This mirrors the belief and idea held by Participant 2 that sharing within the Krikey app would be improved and made more interesting if they were allowed to directly message their own friends and family without necessarily having to share information to the broader Krikey community. The researcher is positive that these few trends and themes could be expounded on and further refined with more time. However, for the sake of this study, these few insights will be the ones primarily highlighted. More data can be found in Appendix A regarding the Demographic and Observation questions. The following Discussion section will focus on what this data means for the world of Augmented Reality and the sharing community, at large.

Discussion

This study focused on how users shared information within AR. To that end, the researcher focused their attention on asking questions to get at the heart of what defines sharing and interaction, why sharing occurs, and how the process can be enhanced by AR. The researcher tested two participants by asking them questions about their current sharing habits, followed by their use of an AR app called Krikey. After ten-minutes, the researcher asked the participants follow-up questions to gauge their level of comfort with the app and their overall feelings towards sharing utilizing AR. Ideally, this study will be the springboard for future research into the position that AR plays within society.

As an emerging technology, AR is only becoming more prevalent and research like this study can help guide it into a more user centered platform. For example, during the study participants had to do things like awkwardly squat or move while attempting to use the AR app. The researcher believes this is due to the way that the app scans and models the space that the user is in. Future AR products need to carefully consider the ways that users move in order to design better experiences. Regarding specific sharing methods, participants in this study seemed to dislike “old” technologies like email as a primary way of showing friends and family what they are doing on a day to day basis. The researcher believes that the participants maintain this concern from their previous social media use. The seeking of familiarity between their previous social media use and the Krikey app did not end at their likes and friend list.

One of the participants was very interested in the idea of sharing other users videos with other platforms. This leads the researcher to believe that the participant was

more interested in the creations of other users within the Krikey community as opposed to the participant's own creations. This information can be used when designing social AR experiences by considering the ways that users currently use popular social networking sites and providing similar interactions from those platforms in the AR app. By doing this, the designers help to motivate users to share and interact more consistently. Another example of blending the digital and physical spaces occurred when Participant 2 attempted to record the researchers within their AR video/environment. The researcher believes that the participant was both attempting to be humorous while simultaneously testing the mapping capabilities of the AR app itself. By allowing users to interact with people in their immediate environments, designers open up the option for physical group play and interaction that is mediated and shareable through AR. This creates a social environment that users can explore in a variety of ways.

From the information gathered above, it would seem that in order to improve sharing within AR, a few things need to be explored. As posited in the Results section, AR needs to establish its place within society and explain to the end user why it matters and how it can better assist each user in their effort for maintained self-expression. On top of that, AR needs to provide its base with the ability to further curate and interact with each other in ways that support and enhance the current sharing trends. By further examining the social media field, AR can continue to build tools that give users direct access to each other (i.e. direct messaging, video sharing, etc.) while also highlighting the more nuanced creations that can occur only within AR (for example, overlaying digital environments like a jungle into the physical world of a person's office space).

Future Work

Group Behavior

How does AR affect the process of creation and maintenance of groups? This question aims at examining the ways that AR can change interactions between groups of people based on their perceived levels of interest both with the app and the group itself. The process of creating and organizing a group is immense and requires a variety of individuals to fill very specific roles within the group dynamic. For example, groups generally have leaders and followers. A leader has a specific set of rules that they must follow in order to successfully execute their role (i.e. giving guidance, sharing information, etc.). In contrast, the followers within that group must be able to follow the guidance of the leader. By following, the individuals within the follower category fulfill their duty to the overall group dynamic. However, even within this overly simplistic two role model, group interactions can inherently change the overall roles and abilities of the individual members. For example, within the context of AR users and the embodied agents that they interact with, Miller and their colleagues (2019, p. 4) noted a change in a user's behavior with embodied agents if there was mention of another human's presence observing the participant's session.

The users, in that instance, seemed to act differently because the additional human presence added perceived additional pressure to the performance of certain tasks. "Even though participants had no contact with other participants, the implied presence of others was sufficient to elicit a social facilitation effect" (Miller et al., p. 3, 2019). The social facilitation effect noted by Miller et al. is a theory that states that individuals will perform

easy tasks better in the presence of others but will stumble and make mistakes on more complex tasks if under observation by the exact same group. The focus of social facilitation is on the user/participant's personally perceived ability of complexity and their reaction to the presence of another that they believe to be judging them (Miller et al., p.3). Along those same lines, another area of note is that of self-presentation. "Self-presentation theory posits that the audience strongly motivates the participant to perform well, which aids performance regardless of difficulty. The difference between easy and hard tasks arises when the performer becomes embarrassed or distracted by their poor performance on hard tasks" (Miller et al., 2019, p. 3). This theory examines the relationship between performance and presence among groups of varying sizes and could further examine the ways that people's interactions change based on their personal perceptions.

The researcher believes that these theories and interactions, along with further examinations of the ways that people form groups, will benefit the research related to augmented reality and its use among the general population.

Ethics of AR

Technology and ethics have a unique relationship. Some technologies universally increase the well-being of all humans while others can improve the living standards of a few while harming many others. As a technology that is continuing to grow and invade new areas of society, AR presents interesting new ethical questions for humanity. Every technology should take the time to examine the ways that it can be misused by others.

The research has included a small section on some ethical issues that arise from the use of

AR and an ethical framework that can begin to examine and answer some of the questions associated with the technology.

One question that arises when dealing with AR is the question of agents and abuse. Is it ethical to abuse an “artificial” character in virtual/augmented reality? However, in order to even begin to answer the proposed question, others must first be examined. What is abuse? What is abuse of a non-human entity? What is the morality of abusing one’s one property? Is the AR embodied agent in question even property? What even defines humanness or personhood? By answering these questions, the issue of abuse becomes much easier to manage and comprehend. For example, most people would agree that abusing a human is wrong, regardless of age, size, gender, or intelligence. However, the researcher believes that most people would not mind if a cellphone owner abused their own cellphone. This is because cellphones are viewed as generally replaceable objects.

Meaning that their value is directly tied to a dollar amount and that only. So, if someone were to abuse their own phone, they would be hurting their own pocketbooks and nothing more. At the same time, someone abusing a human of any kind would be seen as a monster because there is no theoretical dollar amount to place on a human life. By establishing humanity, property, and abuse, certain act either become tolerable or abhorrent. The researcher would like to focus more attention on the understanding of human-computer interaction from a philosophical position in future studies.

Limitations of Study

Although this study is unique and prescient, there are some elements that cannot be tackled to their full potential given the brevity of the research period and small size of the research pool. If the researchers had more time and the ability to reach a more robust sample group, the data found within this study could be better utilized. As it stands, this research will simply be the launch point for future studies in the field of digital socialization and HCI.

During the process of creating and conducting this research, a few ideas occurred to the researcher that would have been a great asset to the study. For one, the initial questions that were asked to the participants yielded responses that were not specifically within the scope of the topic being studied. However, the questions asked did yield some interesting data, nonetheless. As the research progressed, the researcher took it upon themselves to create a list of tasks and improved questions that would more directly address the topics being discussed within this paper (see Appendix B for updated questions and task list). The creation of the task list came about from the observation section of the experiment. During the observations, the participants seemed to get sidetracked with the app itself (which is a good sign for the future of AR apps) but they did not share as many videos with their various communities as the researcher had hoped. In order to correct that behavior for future studies, a task list with specific prompts to share with various groups and perform specific social interactions would better focus the participants on the task of sharing. The questions were revised in order to delve even deeper into the sharing functionality and to get a better understanding of the participants feelings towards sharing within AR.

Aside from the revision of questions and the creation of a task list, the researcher also would have liked to use another thematic analysis research methodology in order to parse more specific data points. The more ideal approach to creating a theme for this study would have been to examine the data from a general angle and apply inductive thematic analysis. In that way, a theme regarding interactions and sharing could more naturally emerge from the data itself. Given that the dataset was small and the numerous time constraints associated with the study, the more theoretical analytic approach was taken. This leads the researcher to discuss another point regarding the study and that is the inclusion of more participants for the research itself. By recruiting more participants, the researcher would have been able to obtain more data which could have lent itself to better understanding the social impact of AR and the types of features that users expect to use when sharing in that medium. With more time, the researcher would have liked to recruit further participants and conduct this experiment with a focus more on the latent, inductive thematic analysis.

Conclusion

AR presents designers and technologists with a unique opportunity. The ability to place real digital information within real physical space can create some interesting interactions (i.e. Google's use of AR to assist people with directions as they're walking down the street). As AR continues to grow in popularity, more creators will find more interesting ways to use the technology. Through this project, the researcher hopes to further the discussion around AR and present more examples of useful interactions. In the future, the researcher would like to return to this study and create a more robust experiment that would genuinely showcase the ways that sharing and AR can work together.

Appendix A

Preliminary Demographic Questions

1. What is your name?
2. What is your age: ____ years
3. How do you identify your gender?
 - Nonbinary/genderqueer
 - Woman
 - Man
 - A gender identity not listed (please describe): _____
4. How do you identify your race/ethnicity (select all that apply)?
 - African/Africana
 - Arab/Middle Eastern
 - Black/African American
 - Caribbean
 - East Asian/Asian American (e.g. Korean, Chinese, Japanese)
 - Filipina/Filipino/Filipinx
 - Latina/Latino/Latinx/Hispanic
 - Native American/American Indian/Alaska Native
 - Pacific Islander
 - South Asian/Asian American (e.g. Indian, Thai, Nepali)
 - White/European
 - Racial/ethnic identity not listed (please describe): _____
5. What is your level of education?
 - Some High-School
 - High-School Diploma
 - Some College
 - Associates Degree
 - Bachelor's Degree
 - Master's Degree
 - Doctorate Degree
6. To what extent do you enjoy sharing personal information:
 - Not at all enjoyable
 - Slightly enjoyable
 - Moderately enjoyable

- Very enjoyable
 - Extremely enjoyable
7. What social media accounts (if any) do you use?
 - Twitter
 - Facebook
 - Instagram
 - Snapchat
 - TikTok
 - Other (please describe):
 - I do not use any
 8. How much time do you spend on social media, on average, per week?
 9. What information do you share through social media (i.e. photos, videos, messages)?
 10. Describe a positive interaction you had when sharing on social media.
 11. Describe a negative interaction you had when sharing on social media.
 12. What kind of content do you share?
 13. Where do you share information, generally?
 14. Why do you share that information?
 15. Who do you share that information with?
 16. Have you ever used Augmented Reality before?
 - i) If so, what kind?
 - ii) For what purpose?

Interview/Observation Questions

1. What are some initial impressions you have from using the app?
2. What did you like about the app?
3. What did you find challenging about the app?
4. How was navigating the app?
5. How many games were you able to play?
6. How would you like to use this app with your friends?
7. Did you watch the videos of other users on the app?
8. On a scale of 1 to 5, 1 being least 5 being greatest, rate your satisfaction with using the app?
9. Where you able to successfully share with the app?
 - a. If so, what did you share?
 - b. Why did you share that?
10. Would you share your AR video using other platforms?
 - a. If so, do you know how?
11. What would make you share your video (i.e. other users you know, etc.)?
12. How confident are you in your knowledge, and use of, the app?
 1. Very Confident
 2. Confident
 3. Not very Confident
 4. No Response
13. Who do you think the target audience is for this app?
14. Is there anything else you'd like to tell me that I didn't ask you?

Appendix B

Task List and Updated Questions

Task 1: Download App

Task 2: Find Games in App

Task 3: Play games

Task 4: Find Community Live feed

Task 5: Find Profile Gallery

Task 6: Share a video to the Community Live Feed

Task 7: Find Game Pieces Gallery

Task 8: Share Game Piece w/ Social Media

Task 9: In Community Live Feed, share another User's video

Task 10: Take a screenshot and share that through Social Media

1. What did the user share with others?
2. In terms of time of day, when does the user prefer to share information with their inner circle?
3. What information does the user feel comfortable sharing with their inner circle?
4. What information does the user feel comfortable sharing with outside entities?
5. What information does the user feel uncomfortable sharing with their inner circle?
6. What information does the user feel uncomfortable sharing with outside entities?
7. In terms of physical location, where does the user prefer to be when sharing information with their inner circle?
8. Regarding the app, was there any part of the sharing process that was difficult to achieve?
9. While sharing the app's video/screenshot through other platforms, was there any concern that the user had?
 - a. What was that concern?
 - b. Why was that a concern?
10. In terms of content within the video, what was easier to share using the app?
11. Was the user comfortable having their face recorded in a video snippet?
 1. If not, why?
12. Would the user share these videos with other social media sites?
 1. If so, which sites?
 2. Why?
13. What content, within the video itself, makes the user more likely to share it?
14. What content, within the video itself, makes the user less likely to share it?
15. What are some of the unique aspects of sharing that occurs online as opposed to in real, physical life?

16. What is the maximum number of people the user feels comfortable knowing personal information about them? (for example: health information)

Appendix C

Follow-Up Questions

1. How often did you use the app?
2. How many times did you share with the app?
3. Did you share using other mediums (i.e. in-person, SMS messaging, etc.)?
4. Share some of your positive interactions with the app.
5. Share some of your negative interactions with the app.
6. Where did you use the app the most?
7. Where did you use the app the least?
8. What was the easiest task to do in the app?
9. What was the hardest task to do in the app?
10. Is there anything else you'd like to add (related to the study, the app, or AR)?

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